

Developing a Better Method of Tag Attachment for Cetaceans

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LONG-TERM GOALS

The goal is to develop, test, and use some novel methods of tag attachments to cetaceans (1) to increase attachment duration, (2) minimize the negative effects to the individual, and (3) to increase types of tags thus broadening the options for tag deployment and duration of attachment.

OBJECTIVES

The primary goal is to increase the duration of tag attachment while limiting the detrimental effects of placing an anchoring device in or on animals. I propose to develop and test some novel approaches for attaching instruments to marine mammals, especially large whales. Long-term attachment requires a firm and biocompatible anchor into the animal that causes the least amount of injury and infection and resists the tendency for rejection. I propose a lateral movement of a prong (called an anchoring wing) after tag penetration that would be more effective as a deterrent to tag rejection and would also be coupled with antibiotic injection. The combination of a more secure anchor, more antiseptic deployment, and a smaller tag will increase the longevity of tag deployments. Also I will develop and test small modifications to suction-cup attachments (i.e. post with barb) that will increase the duration of attachments of instruments via suction cups. Finally, I will develop and test a barb attachment with external tag that would minimize the implantable portion of the tag while allowing prolonged attachment (e.g. 1-4 weeks) beyond that afforded by suction-cup attachments (0-2 days). These attachments will be tested first on stranded marine mammal carcasses, then miniature renditions tested on live captive animals, and then tested and used on animals in the wild.

APPROACH

The first task was a thorough review of the literature and production of an annotated bibliography that would be made available to anyone that is considering tagging large whales. This document will allow others to quickly review who has tried what, and allow them access to these papers/reports so they can more efficiently and effectively design new tags.

Secondly I will design and build three types of tags attachments: (1) implantable tag attachment that involves laterally spreading “wings”, (2) barb attachment with external tag, and (3) suction-cup attachment with external tag. The implantable tag attachment wings will deploy after the tag is imbedded

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in the whales tissue. This mechanism would greatly increase the holding power of the tag, decrease the amount of friction and drag during deployment, and allow slightly greater penetration thus greater duration of attachment. I hope this type of design would allow tag attachments of 6-8 months to more than a year. The barb attachment will consist of a 6 -7 cm long barb that penetrates the whales skin and blubber and has small prongs that anchor the barb into the tissue. The external tag would be hydrodynamically shaped to minimize drag and increase downward force so the tag remain flush to the whale's surface. Additionally, a spring-loaded hinge attaching the external tag to the barb would assist in keeping the tag flush to the whale. This type of design should allow attachments of 2-4 weeks and with a release mechanism allow recovery of the tag. The third attachment would be a test of various small barbs added to suction-cups. Suction cups have been used successfully to place small radio tags on whales and dolphins for periods of hours to a maximum of 2 days. To increase attachment duration, a small barb would penetrate the skin and blubber thus restricting the posterior movement of the tag as drag forces act laterally. I also will experiment with various methods that prolong or actively increase the vacuum inside the suction cup.

These new methods of tag attachment will be designed in SolidWorks software to allow configuration details and some hydrodynamic issues to be resolved. Then working models of the designs will be fabricated and tested in a flume at MLML under various flow regimes and using the deployment methods to test flight characteristics. Working models will then be placed using air guns, crossbows, or a pole on to dead stranded whales to test penetration and holding capacity.

Bill Watson is the principle engineer helping with this project. He will design the working models and conduct most of the fabrication. At MLML, he has access to metal and wood lathes, an electronics shop, and two laboratories that provide bench space. Bill also will assist with laboratory and field testing of all designs.

WORK COMPLETED

The publication review and resultant annotated bibliography has been completed (see attached appendices). Most of the published works in the primary literature and some grey literature were reviewed and the salient points regarding tag design, placement, attachment, and longevity were summarized. This effort was an attempt to place as much of the literature on tag development in one place, thus current and future researchers would have a common place from which to start. New tag design would benefit because redundancies would be minimized, designs that were tested and failed would not be tried increasing efficiency, and the thoughts of past researchers might stimulate new ideas for tag design. We also reviewed the literature on barnacle attachment to assess whether there was anything in that literature that might provide insight into tag attachment given the million years of evolution of barnacle attachment on whales.

The attachment "wings" for the implantable have been designed (Fig. 1), and a working model has been bench tested. The current model can fit inside a tube of 120 mm, but we want to reduce the size eventually so that it can fit inside a 190 mm ID tube that would be deployed in some of the standard implantable tag in use today (N. Gales, pers. comm.). This design consists of a small electric motor and specialized gearing that allows full deployment of two stainless steel wings that rotate out in opposite directions (Fig. 2). The next step is to test the deployment in some tissue to assess whether there is enough torque to allow the wings to completely cut through and deploy in blubber or muscle tissue, then measure the change in tension required to pull the tag out when the tag has the wings deployed

and when the wings are not deployed. This will provide some empirical data regarding the improved holding power of the wing attachment.

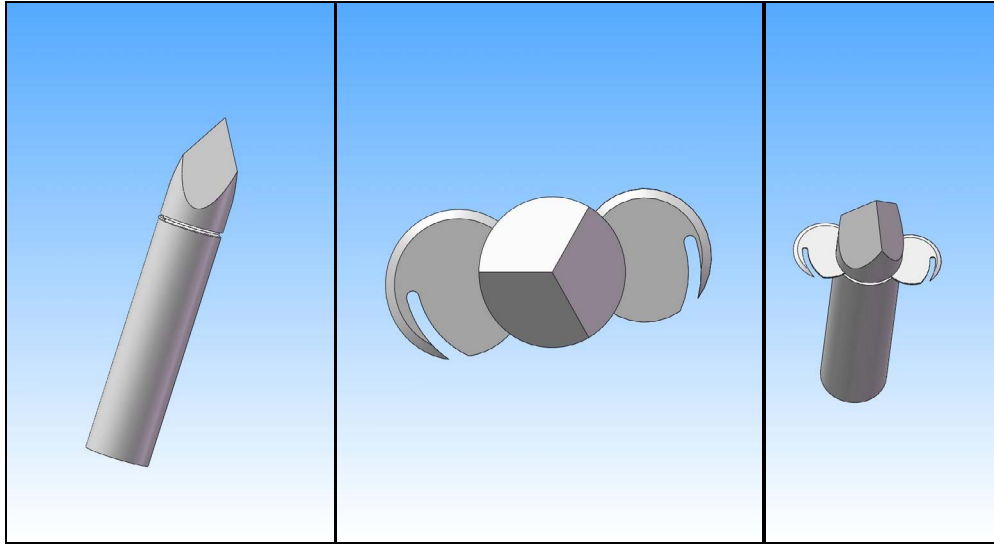


Figure 1. The first panel depicts a generic projectile front with the attachment wings within the tag body. The middle panel shows from the anterior end of the tag the fully engaged “wings”, and the panel on the right depicts the wings deployed from the tag cylinder.

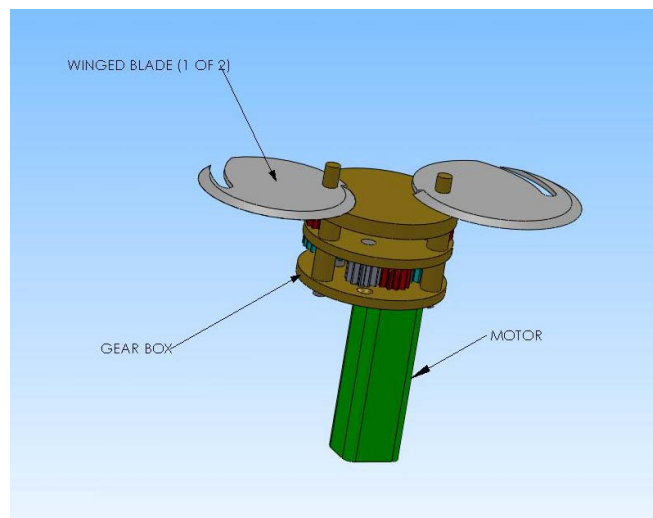


Figure 2. SolidWorks software rendition of the gearing mechanism and motor driving the deployment of the stainless steel wing attachments for the implantable tag. This design has been built and bench tested.

We have designed and constructed a number of possible modifications to the suction-cup attachment that mostly involve the use of a small barb attached to the base of the suction cup (Fig. 3). We have bench tested this design and realize that the barb must be at least 2 cm in length to properly penetrate the skin and blubber and allow the suction cup to properly deploy. The next step is to test the barbed suction cup attachment with the eventual deployment method (e.g. pole, cross bow, and air gun).

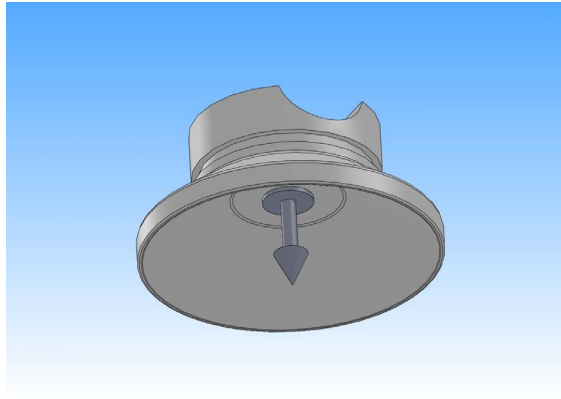


Figure 3. Suction cup attachment with central barb. The barb is 2-4 cm in length, and has a cone shaped barb to allow the suction cup to spin so the tag can be oriented parallel to the direction of water flow.

The barb attachment (Fig. 4) is still in development and has not been constructed as yet. A small modification to the original proposed design is being considered. This is a spring-loaded hinge to force the tag to be held adjacent to the skin, thus minimizing motion on the whale's skin and keeping the antenna vertical to the whale's back, similar to the design by Goodyear (1993).

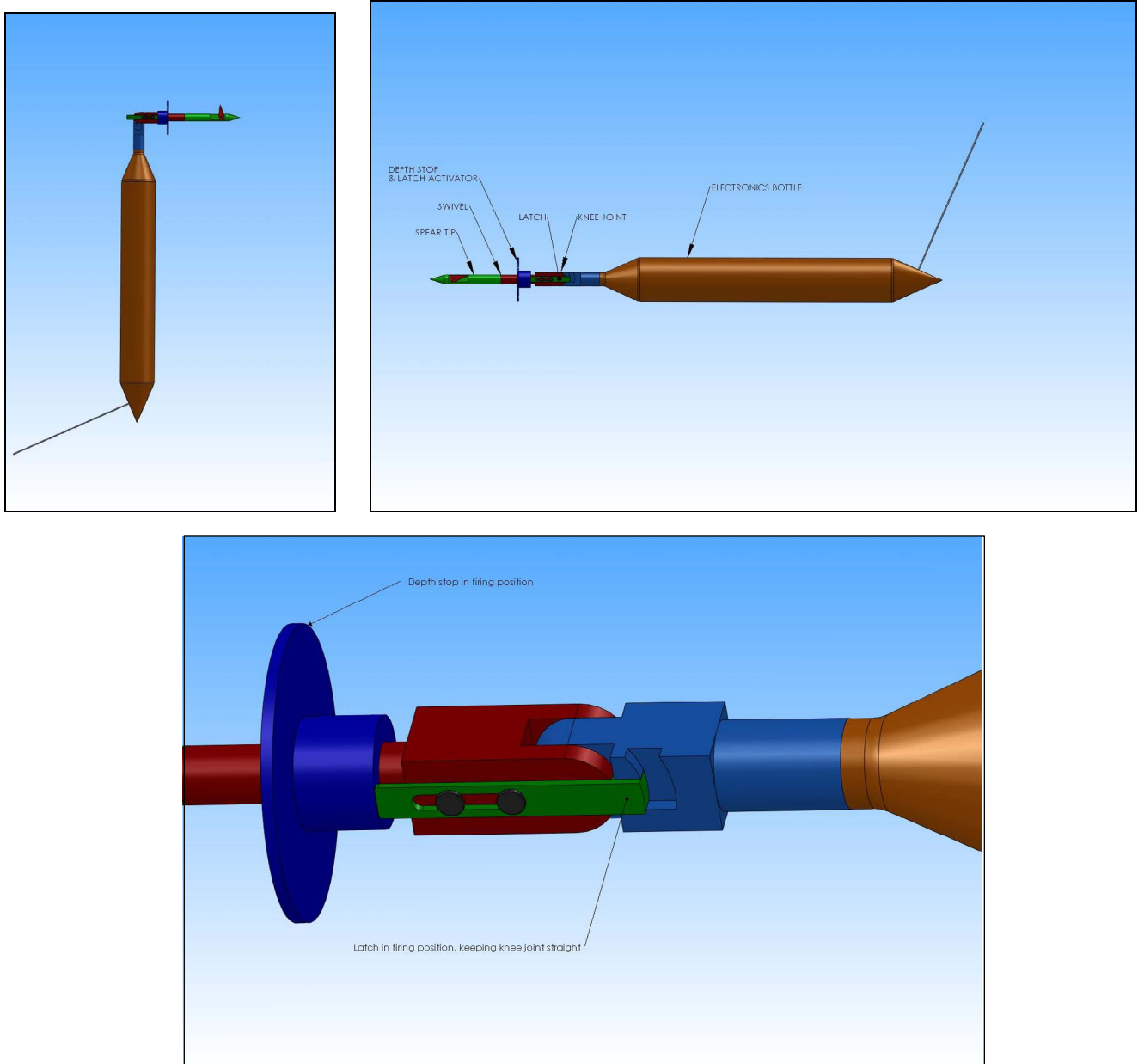


Figure 4. Barb tag, with the upper left figure showing barb in the animal and the articulating "knee joint" allowing the tag to be perpendicular to the whale, upper right panel is tag when fired and knee joint holding the barb and tag horizontal during flight,, and lower left panel showing the details of the knee joint.

RESULTS

We now know that we can construct a small, motorized gear system that can deploy two stainless steel “wings” laterally from a implantable tag. We need to reduce the size by 15% so that it can be placed inside the 119 mm ID cylinder of current implantable tags. We realize the small electric motor needs to be slightly larger to provide more torque as the wings deploy. We have sourced a new motor that is small enough and provides 2-3 times the power of the current motor.

The barbs attached to the suction greatly decrease the lateral movement of the suction-cup attachment previously used by all researchers. Laboratory tests indicate that the barb should be at least 2-cm long, with a 3 mm flange. The barbed suction cups deploy almost as easily as the suction cup alone, thus addition of a barb will not affect suction cup deployment as used previously.

We have learned that the barbs used with suction cups must be at least 2 cm in length, must have at least a 3 mm flange for holding power, and must be at least 2 mm in diameter to not bend on impact. Bench tests have demonstrated that the barb must be perpendicular to the whale's surface for the barb and suction cup for proper attachment. If somewhat off perpendicular, the suction cup does not attach properly and only acts as drag rapidly pulling barb out of the animal. With increased diameter and length of the barb, increased flange, proper orientation, the suction cup does not move laterally thus reducing the probability of rapid detachment. I expect that the use of a barb on suction cups will increase the duration of attachment from 1-2 days to 3-6 days.

IMPACT/APPLICATIONS

Modifications to previous tag attachments for large whales are being developed with the goal of increasing the duration of attachment, decreasing harmful affects to the individuals, and possibly increasing the ease of attachment. If successful, these concepts would be useful for all researchers placing tags on large whales. These developments would be applicable for short-term (1-6 days) attachments using suction cup and an external tag, moderate-term (1-4 weeks) attachments and recoveries of tags using a barb attachment and external tags, and long-term (1-12 months and possibly longer) attachments of implantable tags. These could be used on all studies of large whales throughout the world.

RELATED PROJECTS

Currently there are at least four researchers throughout the world that have developed and are using implantable tags placed in large whales to assess long-term movements and dive behaviors. We are working relatively closely with one of these researchers (Nick Gales – Australian Antarctic Division) to modify his implantable tag with a new tip that would improve penetration and holding power via the deployable “wings”.

REFERENCES

Goodyear, J.D. 1993. A sonic/radio tag for monitoring dive depths and underwater movements of whales. *The Journal of Wildlife Management*. 57(3):503-513.